

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stefanie R. Chiras et al.

Application No.: 10/722,558

Confirmation No.: 4980

Filed: November 28, 2003

Art Unit: 2812

For: PROCESS FOR FORMING AN
ELECTRICALLY CONDUCTIVE
INTERCONNECT

Examiner: R. A. Booth

SECOND REPLACEMENT APPEAL BRIEF

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a Second Replacement Appeal Brief in response to the Notification of Non-Compliant Appeal Brief (37 CFR § 41.37) dated June 29, 2007, and is in furtherance of the Notice of Appeal in this application.

The fees required under § 41.20(b)(2) have already been paid.

This brief contains items under the following headings as required by 37 C.F.R. § 41.37 and M.P.E.P. § 1206:

- I. Real Party In Interest
- II. Related Appeals and Interferences
- III. Status of Claims
- IV. Status of Amendments
- V. Summary of Claimed Subject Matter
- VI. Grounds of Rejection to be Reviewed on Appeal
- VII. Argument
- VIII. Claims

- Appendix A Claims
- Appendix B Evidence
- Appendix C Related Proceedings

I. REAL PARTY IN INTEREST

The real party in interest for this appeal is:

International Business Machines Corporation

II. RELATED APPEALS, INTERFERENCES, AND JUDICIAL PROCEEDINGS

There are no other appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

A. Total Number of Claims in Application

There are 32 claims pending in application.

B. Current Status of Claims

1. Claims canceled: 2 and 16
2. Claims withdrawn from consideration but not canceled: 23-30
3. Claims pending: 1, 3-15, 17-22, 31 and 32
4. Claims allowed: 0
5. Claims rejected: 1, 3-15, 17-22, 31 and 32

C. Claims On Appeal

The claims on appeal are claims 1, 3-15, 17-22, 31 and 32

IV. STATUS OF AMENDMENTS

Applicant did not file an Amendment After Final Rejection.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention according to claim 1 relates to a process for forming an electrically conductive metallic interconnect in a via in a dielectric. See page 3, lines 1-2 of the specification and figures 1-8. The process comprises providing a dielectric layer 10 in a substrate 8 wherein the substrate 8 comprises electrically conductive lines 12. See page 3, lines 3-5 and page 4, lines 15-20 of the specification and figure 1. The dielectric layer 10 comprises a low-k dielectric having a dielectric constant of less than 3.9. See page 1, lines 7-8 and page 4, lines 22-28 of the specification and figures 1-8. A trench or via 18 is formed in the dielectric layer 10 and electrically conductive line 12 in the substrate 8 is exposed. See page 5, lines 3-6 of the specification and figure 2.

A first liner layer 22 is deposited on the walls and bottom of the trench or via 18. See page 5, lines 25-28 of the specification and figure 6. Residual contamination is removed from the bottom of the trench or via 18. See page 6, penultimate paragraph and figure 7. A second liner layer 24 is deposited on the walls and bottom of the trench or via 18. See page 7, lines 1-4 of the specification and figure 8. A seed layer is deposited in the trench or via and the trench or via with electrically conductive material. See page 3, lines 11-12 of the specification.

According to claim 3, the electrically conductive lines comprises copper, aluminum or alloy thereof and according to claim 4 the electrically conductive lines comprise copper or alloy thereof. See page 5, lines 1-2 of the specification.

According to claims 5 and 19, the first liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides and combinations thereof and according to claims 6 and 21, the first liner layer comprises Ta. See page 5, lines 2-3 of the specification.

According to claim 7, the residual contamination is removed by etching and according to claim 8 the etching comprises an argon etching. See page 5, penultimate of the specification.

According to claims 8, 9 and 20 the second liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides thereof and combinations thereof and according to claims 10, 11 and 22, the second liner layer comprises Ta. See page 7, lines 1-5 of the specification. Accordingly to claim 12, the seed layer comprises copper. See page 7, lines 17-19 of the specification. Accordingly to claim 13, the conductive material for filling the trench or via comprises copper. See page 7, lines 17-19 of the specification.

According to claim 15, the process further comprises depositing an adhesion liner layer 20 prior to depositing the first liner layer and the residual contamination and adhesion liner layer are removed from the bottom of the trench or via prior to depositing the first liner layer. See page 5, lines 7-14 and 18-24 of the specification and figure 3. According to claim 17, the adhesion liner layer comprises a nitride of Ta, W or Ti and according to claim 18, the adhesion liner comprises TaN. See page 5, lines 7-14 of the specification.

According to claims 30 and 31, the Ta comprises alpha-phase Ta. See page 5, penultimate line of the specification.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

- A. Has the examiner established that Claims 1 and 3-14 are obvious under 35 USC 103(a) and therefore unpatentable over the cited art and namely over European 1,233,448 to Lu et al in view of US patent 6,486,059 to Lee et al.?
- B. Has the examiner established that Claims 15 and 17-22 are obvious under 35 USC 103(a) and therefore unpatentable over the cited art and namely over European 1,233,448 to Lu et al in view of US patent 6,486,059 to Lee et al and further in view of US patent 5,897,368 to Cole Jr. et al.?
- C. Has the examiner established that Claims 31 and 32 are obvious under 35 USC 103(a) and therefore unpatentable over the cited art and namely over European

1,233,448 to Lu et al in view of US patent, 6,486,059 to Lee et al and further in view of US patent 6,140,234 to Uzoh et al or US patent 6,221,757 to Schmidbauer et al.?

VII. ARGUMENT

A. Lu et al and Lee et al Fail to Render Obvious Claims 1 and 3-14

Claims 1 and 3-14 were rejected under 35 USC 103(a) as being unpatentable over European 1, 233,448 to Lu et al (hereinafter referred to as "Lu") in view of US patent 6,486,059 to Lee et al. (hereinafter referred to as "Lee"). The cited references fail to render obvious the present invention. In particular, as appreciated by the Examiner, Lu et al., does not explicitly disclose employing a low k dielectric as recited in the claims. As discussed in the specification, the present invention relates to reducing field induced metal contamination of the dielectric and/or leakage failure of the metallic interconnect and is of especial significance when the dielectric is a low-k dielectric. On the other hand, Lu et al. are concerned with eliminating overhang in liner/barrier/seed deposition and not with the problems addressed by the present invention which are especially pronounced when the dielectric is a low-k dielectric as recited in the present claims. Although, Lee et al. discloses low k dielectric, no motivation exists in Lee et al. or Lu et al. to suggest that the problems of reduced field induced metal contamination of low k dielectric would or could be achieved if a low k dielectric were employed in the process Lu et al.

Persons skilled in the art, faced with the problem field induced metal contamination of low k dielectric would not be motivated by the cited art to combine Lee with Lu. No expectation of reducing field induced metal contamination of low k dielectric exists in the cited art.

Concerning obviousness, *Graham V. John Deere*, 383 U.S. 1,148 U.S.P.Q. 459 (1966) outlines the approach that must be taken when determining whether an invention is obvious. In *Graham*, the Court stated that a patent may not be obtained if the subject matter would have been obvious at the time the invention was made to a person having ordinary skill in the art, but emphasized that nonobviousness must be determined in the light of inquiry, not quality.

Approached in this light, §103 permits, when followed realistically, a more practical test of patentability. In accordance with *Graham*, three inquiries must be made in determining whether an invention is obvious:

- (1) The scope and content of the prior art are to be determined.
- (2) The difference between the prior art and the claims at issue are to be ascertained.
- (3) The level of ordinary skill in the pertinent art are resolved.

Against this background, the obviousness or nonobviousness of the subject matter is determined. Secondary considerations, such as commercial success, long felt but unsolved needs, failure of others, etc., can be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.

In conjunction with interpreting 35 U.S.C. §103 under *Graham*, the initial burden is on the Examiner to provide some suggestion of the desirability of doing what the inventor did, i.e. the Examiner must establish a *prima facie* case of obviousness. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention, or the Examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references.

To establish a *prima facie* case of obviousness, three basic criteria must be met:

1. There must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference.
2. There must be a reasonable expectation of success.
3. The prior art reference (or references when combined) must teach or suggest all the claim limitations.

The teaching or suggestion the reasonable expectation of success must both be found in the prior art and not based on Applicants' disclosure. *In re Vaeck*, 947 F2d 488, 20 U.S.P.Q. 2d

1438 (Fed. Cir. 1991). See MPEP § 2143-§2143.03 for decisions pertinent to each of these criteria.

The discussion in *In re Kotzab*, 55 U.S.P.Q. 2d 1313 (Fed. Cir. 2000) at page 1317 is also relevant wherein the Court stated:

A critical step in analyzing the patentability of claims pursuant to section 103(a) is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided by the prior art references and the then-accepted wisdom in the field. See *Dembiczak*, 175 F.3d at 990, 50 USPQ2d at 1617. Close adherence to this methodology is especially important in cases where the very ease with which the invention can be understood may prompt one “to fall victim to the insidious effect of a hindsight syndrome wherein that which only the invention taught is used against its teacher.” Id. (quoting W.L. Gore & Assoc., Inc. v. Garlock, Inc. 721 F.2d 1540, 1553, 220 USPQ 303,313 (Fed. Cir. 1983).

The mere fact that the cited art may be modified in the manner suggested by the Examiner does not make this modification obvious, unless the cited art suggest the desirability of the modification. No such suggestion appears in the cited art in this matter. The Examiner’s attention in kindly directed to *In re Lee* 61 USPQ2d 1430 (Fed. Cir. 2002), *In re Dembicza et al.* 50 USPQ2d. 1614 (Fed. Cir. 1999), *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984), *In re Laskowski*, 10 USPQ2d. 1397 (Fed. Cir. 1989) and *In re Fritch*, 23, USPQ2d. 1780 (Fed. Cir. 1992).

In *Dembiczak et al.*, supra, the Court at 1617 stated: “Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references. See, e.g., C.R. Bard, Inc., v. M3 Sys., Inc., 157 F.3d. 1340, 1352, 48 USPQ2d. 1225, 1232 (Fed. Cir. 1998) (describing ‘teaching or suggestion motivation [to combine]’ as in ‘essential evidentiary component of an obviousness holding’), In re Rouffet, 149 F.3d 1350, 1359, 47 USPQ2d. 1453, 1459 (Fed. Cir. 1998) (‘the Board must identify specifically...the reasons one of ordinary skill in the art would have been motivated to select the references and combine them’);...”.

Also, the cited art lacks the necessary direction or incentive to those of ordinary skill in the art to render a rejection under 35 USC 103 sustainable. The cited art fails to provide the degree of predictability of success of achieving the properties attainable by the present invention needed to sustain a rejection under 35 USC 103. See *Diversitech Corp. v. Century Steps, Inc.* 7

USPQ2d 1315 (Fed. Cir. 1988), *In re Mercier*, 187 USPQ 774 (CCPA 1975) and *In re Naylor*, 152 USPQ 106 (CCPA 1966).

The present invention could only be derived from the cited art by the use of "hindsight", i.e. by knowing what Applicants' invention was in advance from Applicants' disclosure, and then *ex post facto* reconstructing Applicants' invention from the prior art after a thorough search. It is impermissible under 35 U.S.C. 103 to use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. See *In re Fine*, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). Furthermore, it is well settled that hindsight reconstruction using the patent application as a guide through the maze of prior art references, combining "the right references in the right way" so as to achieve the result of the claimed invention must be avoided. See *Grain Processing Corp. v. American Maize-Products Corp.*, 5 U.S.P.Q.2d 1788 (Fed. Cir. 1988).

The comments made by the Court in *AIR-vend, Inc. Throne Industries, Inc.*, 229 USPQ 505 at 515 (District Court, Minnesota, 1985) are appropriate here:

The question of obviousness, as the Court of Appeals for the Federal Circuit has acknowledged, is simple to ask, but difficult to answer...The difficulty in answering this question is due in no small part to the strong temptation to resort to and rely on hindsight in formulating the answer. Hindsight, however, is quite improper when resolving the question of obviousness. To use the patent in suit as a guide through the prior art references, combining the right references in the right way to arrive at the result of the claims in the suit is, therefore, also quite improper. Combining the teachings of the prior art to produce the claimed invention absent some teaching, suggestion or incentive supporting this combination cannot establish obviousness.

The rejection of the claims is in the nature of "ought to be tried" which is an impermissible standard under 35 U.S.C. 103 (see *Jones v. Hardy*, 220 U.S.P.Q. 1021 [CAFC, 1984]).

Furthermore, the process of the present invention makes it possible to provide a pure metal contact at the bottom of the via/trench or a Ta/Cu contact which is mechanically robust and tenaciously bonded. The process of the present invention also provides for a good diffusion barrier between the electrically conductive lines such as copper and the dielectric. A comparison

of Figures 9 and 10 illustrate advantages achieved by the present invention. Figure 9, which differs from the present invention in not employing the step of depositing the second liner layer 22, illustrates poor liner coverage on the bottom of the trench or via. On the other hand, Figure 10, which employs the processing of the present invention shows thick lines coverage on the bottom of the trench or via.

In addition, the sputter etch back step employed in the present invention is not for the purpose of removing overhang as required by Lu, but instead is to provide for a more uniform deposit on the sidewalls.

B. Lu et al and Lee et al and Cole, Jr. et al Fail to Render Obvious Claims 15 and 17-22

Claims 15 and 17-22 were rejected under 35 USC 103(a) as being unpatentable over European 1,233,448 to Lu et al in view of US patent 6,486,059 to Lee et al and further in view of US patent 5,897,368 to Cole Jr. et al.(hereinafter referred as Cole, Jr.). The cited references do not render obvious claims 15 and 17-22. Cole, Jr. does not overcome the above discussed deficiencies of Lu and Lee with respect to rendering unpatentable the present invention. Cole, Jr. was relied upon for a disclosure of forming an adhesion layer 22 in a via and removing the adhesion layer from the bottom of the trench prior to depositing additional metallization layers. It would not be obvious to include an adhesion layer in the process of the Lu et al., since the first barrier layer of Lu et al. is disclosed as having already having excellent adhesion properties. See column 2, line 53 and column 3, lines 1-5, for instance. Accordingly, no motivation exists to include a further layer in the process of Lu et al. Moreover, it would not be obvious to remove residual contamination and adhesion liner layer are removed from the bottom of the trench or via prior to depositing the first liner layer since this removal would seem to defeat the purposes of the adhesion layer and the prior art does not disclose any benefit in doing so.

Cole, Jr. does not disclose an adhesion layer as asserted by the examiner. Instead, layer 22 is a seed layer with is used to achieve subsequent deposition from an electroless plating bath. The barrier layers of Lu are not to be deposited by electroless plating but instead by PVD or CVD. Only after depositing the barrier layers in Lu, is there mention of a seed layer like in Cole,

Jr. along with subsequent electroless plating. The art is well aware of the significant differences and requirements for promoting electroless plating as compared to other plating techniques.

C. Lu et al , Lee et al, Uzoh et al and Schmidbauer et al. fail to render Obvious Claims 32 and 32

Claims 31-32 were rejected under 35 USC 103(a) as being unpatentable over European 1,233,448 to Lu et al in view of US patent, 6,486,059 to Lee et al and further in view of US patent 6,140,234 to Uzoh et al or US patent 6,221,757 to Schmidbauer et al. The cited references do not render obvious claims 31 and 32. Uzoh et al and Schmidbauer et al. do not overcome the above discussed deficiencies of Lu and Lee with respect to rendering unpatentable the present invention. Both Uzoh et al and Schmidbauer et al were relied upon for the disclosure of alpha tantalum as a metallization layer. Accordingly, claims 31 and 32 are patentable for at least those reasons as to why claim 1 is patentable.

CI. CLAIMS

A copy of the claims involved in the present appeal is attached hereto as Appendix A. As indicated above, the claims in Appendix A do include the amendments filed by Applicant on February 21, 2006.

Dated: July 13, 2007

Respectfully submitted,

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CLAIMS APPENDIX A

Claims Involved in the Appeal of Application Serial No. 10/722,558

1. A process for forming an electrically conductive metallic interconnect in an via in a dielectric which comprises:

providing a dielectric layer in a substrate wherein the substrate comprises electrically conductive lines, wherein the dielectric layer comprises a low-k dielectric having a dielectric constant of less than 3.9,

forming a trench or via in the dielectric layer and exposing electrically conductive line in the substrate;

depositing a first liner layer on the walls and bottom of the trench or via;

removing residual contamination from the bottom of the trench or via;

depositing a second liner layer on the walls and bottom of the trench or via;

depositing a seed layer in the trench or via and

filling the trench or via with electrically conductive material.

3. The process of claim 1 wherein the electrically conductive lines comprises copper, aluminum or alloy thereof.

4. The process of claim 1 wherein the electrically conductive lines comprise copper or alloy thereof.

5. The process of claim 1 wherein the first liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides and combinations thereof.

6. The process of claim 1 wherein the first liner layer comprises Ta.

7. The process of claim 1 wherein the residual contamination is removed by etching.

8. The process of claim 7 wherein the etching comprises an argon etching.

9. The process of claim 1 wherein the second liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides thereof and combinations thereof.
10. The process of claim 5 wherein the second liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides thereof and combinations thereof.
11. The process of claim 1 wherein the second liner layer comprises Ta.
12. The process of claim 6 wherein the second liner layer comprises Ta.
13. The process of claim 1 wherein the seed layer comprises copper.
14. The process of claim 1 wherein the conductive material for filling the trench or via comprises copper.
15. The process of claim 1 which further comprises depositing an adhesion liner layer prior to depositing the first liner layer and wherein residual contamination and adhesion liner layer are removed from the bottom of the trench or via prior to depositing the first liner layer.
17. The process of claim 15 wherein the adhesion liner layer comprises a nitride of Ta, W or Ti.
18. The process of claim 16 wherein the adhesion liner comprises TaN.
19. The process of claim 17 wherein the first liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides and combinations thereof.
20. The process of claim 19 wherein the second liner layer comprises at least one member selected from the group consisting of Ta, W, Ti, nitrides thereof and combinations thereof.
21. The process of claim 18 wherein the first liner layer comprises Ta.

22. The process of claim 22 wherein the second liner layer comprises Ta.
31. The process of claim 6 wherein the Ta comprises alpha-phase Ta.
32. The process of claim 12 wherein the Ta comprises alpha-phase Ta.

EVIDENCE APPENDIX B

NONE

No evidence pursuant to §§ 1.130, 1.131, or 1.132 or entered by or relied upon by the examiner is being submitted.

RELATED PROCEEDINGS APPENDIX C

NONE

No related proceedings are referenced in II. above, hence copies of decisions in related proceedings are not provided.